Empirical Reformulation of the Universal Soil Loss Equation for Erosion Risk Assessment in a Tropical Watershed.

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Abstract

Efficient intervention to control soil erosion in rural tropical landscapes requires accurate models for predicting the spatial location and intensity of degradation. The Universal Soil Loss Equation (USLE) has commonly been applied for spatial erosion risk assessment in the tropics, but has rarely been validated using ground observations of soil degradation.   As with any empirical model, application in new regions requires calibration before results are used for decision support.   We evaluated USLE effectiveness for predicting erosion in a small watershed in western Kenya based on 420 georeferenced ground observations of ordinal erosion class (3 categories) systematically collected from throughout the basin. Relativized model factors were parameterized using standard remote assessment methods based on interpolated spatial data layers. Inference of degradation status at cultivated sites was estimated by calibration to near infrared diffuse reflectance spectra obtained from sampled soils; diagnostic models based on spectra produced validation accuracies of 78% for three categories.

Association between USLE predicted risk and observed erosion, estimated using mixed effects logistic regression to control for within-site variability, correctly classified only 38% of sites into three degradation classes and model sensitivity for delineating regions of severe degradation was only 28%. Graphical modeling was used to identify those USLE risk factors that were conditionally associated with observed degradation, and an ordinal logistic regression model, employing only these factors was developed. This alternative model, which allowed statistical flexibility in estimating effect direction and strength, correctly predicted ordinal degradation class at 54% of field sites, with 55% sensitivity for the severe degradation class. This result suggests a critical need for efficient ground-based sampling schemes to be used in conjunction with flexible statistical models based on USLE factors for future investments in erosion risk assessment in the tropics.